DEPARTMENT OF THE INTERIOR

TOPOGRAPHICAL SURVEY

BULLETIN No. 59

HOW TO READ TOPOGRAPHIC MAPS

OTTAWA
F. A. ACLAND
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1929

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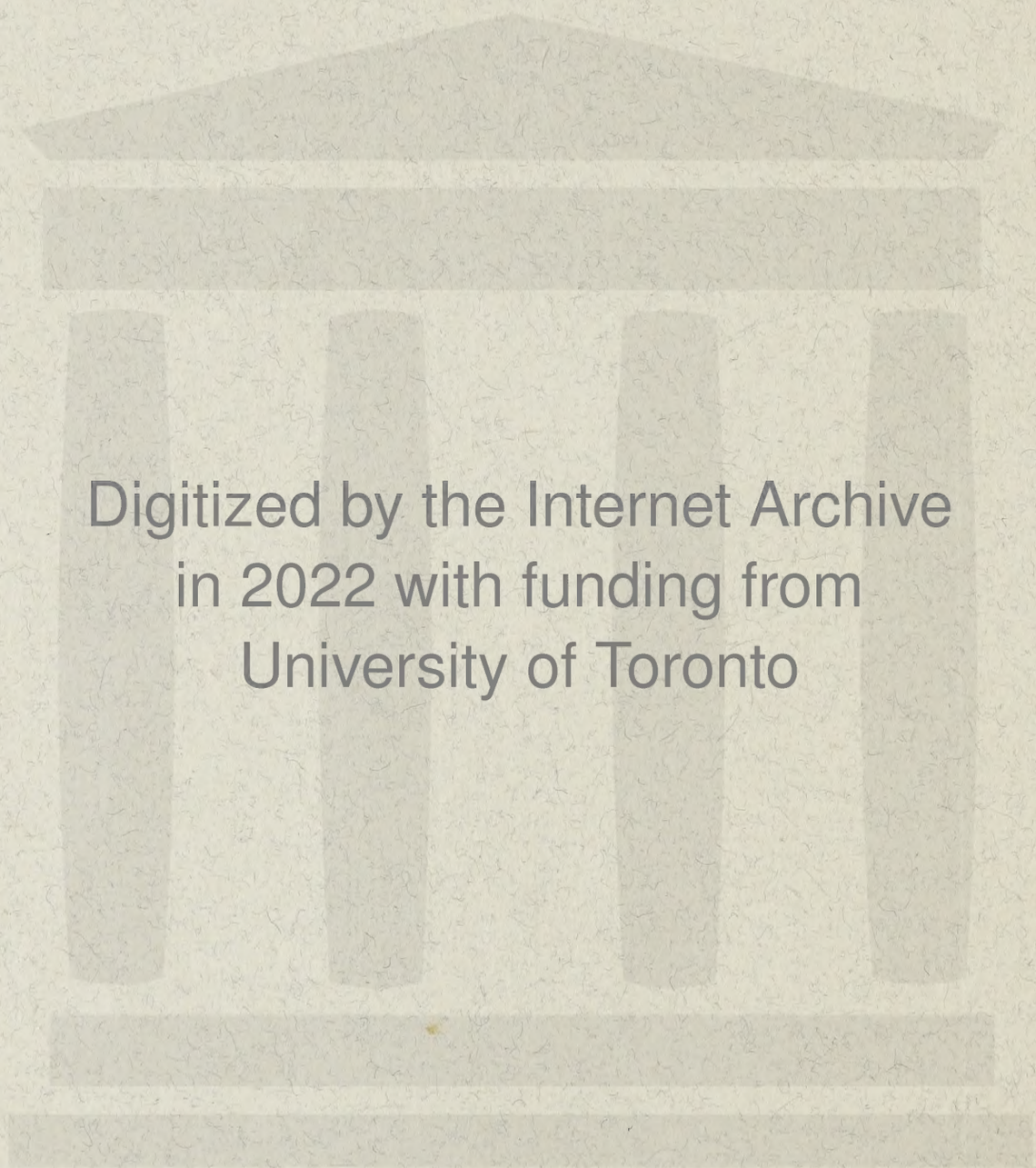

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FOREWORD

This pamphlet, prepared by Mr. E. M. Dennis, D.L.S., was first published in 1926 to present to the school teacher and the general public some information with regard to the proper methods of reading and interpreting Canadian topographic maps. In compiling the information, standard British books upon the subject were freely made use of, a partial bibliography of which is included at the back.

The pamphlet was so well received that the entire edition of 5,000 copies has been distributed and it is now being re-issued to meet the growing demand from educational authorities particularly in the prairie provinces.

In addition to a general explanation of the subject, for those who may wish to make a direct study from examples, detailed descriptions of four of the topographic maps issued by this office are included, respectively, the Winnipeg sheet, the Regina sheet, the Edmonton sheet, and the Banff sheet, of the Sectional Map of Canada.

F. H. PETERS,
Surveyor General.

OTTAWA, March, 1929.

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HOW TO READ TOPOGRAPHIC MAPS

WHAT THEY ARE

A topographic map is a representation on paper drawn to scale of the features of a portion of the surface of the earth. The features shown may be classified into three main divisions: water, including the sea, lakes, rivers, streams, ponds, marshes, swamps, glaciers, snowfields, etc.; relief, including mountains, hills, valleys, cliffs, slopes, depths, etc.; and culture, including the works of man such as cities, towns, villages, buildings, railways, highways, land boundaries, cleared areas, plantations, etc. The degree of exactness in the representation of the features of the area will depend on the relative size of the map to the area mapped, and to the uses to which it is intended to put the information shown. Before a map can be drawn the information to be shown on it must be obtained by a survey, and it is usual to make the survey with such detail and accuracy as is required for the scale of the map to be published. For instance, if a small map is to be issued of a fairly large area it will be manifestly impossible to show on it all the smaller hills and valleys, and the survey need not go into the expensive detail of locating these.

There are several elementary considerations which must be observed in preparing any map but these are especially important with respect to the topographic map. In the first place, to be a true representation of the surface of the ground, a map must be drawn to scale. Distances on the ground must be shown on the map in the same proportion and this proportion must be known. The size of the map will thus bear a definite relation to the size of the area mapped. There are two methods in common use of expressing the scale of a map. One is to express in inches or proportions of an inch on the map the number of miles on the ground. Thus the map-sheets of the Sectional Map of Canada covering the prairie provinces and the Railway Belt and the Peace River block of British Columbia are issued on the scale of one-third of an inch to one mile or, as it is perhaps oftener expressed, one inch to three miles. Townships of the Dominion lands surveys system are six miles square and therefore a township measures on the map-sheet two inches to the side.

The other method of showing the scale of a map is known as the fractional. It is indicated as a fraction $\frac{1}{100,000}$, or as a proportion 1 to 100,000. It means that one unit of measurement on the map represents 100,000 times that unit on the ground. Each scale can be readily converted to the other; thus one inch to three miles is 1 to 190,080 (there are 190,080 inches in three miles). Many maps show both scales. This is possibly the best practice, although where one scale may be very convenient for use, the other is usually awkward, except in places where the decimal units of length prevail. Thus 1 to 100,000 expressed in the other scale is 0.6336 inch to one mile or 1 inch to 1.578 miles.

The matter of scale is very important. Students and pupils should obtain a good grasp of this as otherwise erroneous ideas are liable to be obtained of the relative sizes of areas or countries from the actual sizes of the maps themselves. If all maps were drawn to the same scale, it would be an easy matter to compare actual areas on the ground. All maps, however, are not made for the same purpose and consequently many different scales are used, the scale for each map being given careful consideration before the drawing is commenced. The considerations which are taken into account in deciding upon the scale of the map include the amount of information available from surveys, the use to which

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the information is to be put, the class of people who will be chiefly using the map, the amount of money available for the work, the maps of the area already available, the probable future map requirements of the district, etc.

Having obtained an understanding of the meaning and use of the scale of a map, it is easy to measure or even estimate fairly correctly the distance between any two points shown. In addition to distance another important matter to be kept in mind in looking at a map is that of direction. It is the almost universal custom in topographic maps to have the north at the top of the map. This being so, the bottom is south, the right hand side east, and the left hand west. This arrangement is only a convention but as it has been adopted by map makers generally, it is an essential thing to remember. The directions here mentioned are the true or astronomic north and south, and east and west, and must be distinguished from magnetic direction. The magnetic compass in Canada points to the north magnetic pole which is situated near King William island on the Arctic coast, a considerable distance from the true north pole. Thus, across Canada from coast to coast, true north and magnetic north are not the same except along one line. When east of this line the compass points west of north and when west of it the reverse is true. The so-called agonic line, along which true north and magnetic north are the same, takes a direction slightly west of north and passes through the middle of lake Nipigon. It is customary to show the local variation between true and magnetic north on most topographic maps. In western Canada, however, where the Dominion lands surveys system is in vogue with all survey lines laid out north, south, east, and west astronomically, everyone is so well aware of true direction that a knowledge of the magnetic variation is not of great importance. For this reason, in the past the variation or magnetic declination has not been given on the sheets of the Sectional Map of Canada. As a matter of information it has, however, been decided to show it on future map-sheets.

A third essential of a topographic map is that it shall definitely fix the position of the area mapped in its relation to the earth's surface. This is done by showing the latitude and longitude on the map by what are known as graticule lines. The sheets of the Sectional Map are both named and numbered. To persons living in western Canada the name usually conveys a very good idea of the locality. Outside of Canada such a name does not serve to fix its position with any degree of precision, but when the latitude and longitude are marked on the borders of the map any person the world over can at once determine its exact position.

To sum up, a topographic map is a representation as complete as the scale will permit, of the surface of the portion of the earth in question. In order to show the various features, advantage is taken of conventional signs, abbreviations, different styles of lettering, different thicknesses of lines, hachuring, colours, etc. Even with all these aids, however, it is impossible to present every little detail of the ground but sufficient information is shown to make a topographic map an economic necessity for all who are engaged in earning a livelihood; and a source of pleasure and profit to all who have spare time at their disposal for recreation or study.

WHAT THEY SHOW

From what has already been said it must not be assumed that a topographic map shows the landscape as does a photograph or painting. To a person unacquainted with map reading, a first sight of such a map will be disappointing. A large feature such as a city or large lake will be noticed at once but smaller features must be looked for. The art of reading maps must be acquired the same as ordinary reading. There are difficulties to be surmounted just as in reading a printed page. For one thing, a topographic map is printed on a flat surface and it purports to represent elevations and depressions. It is, there-

fore, necessary to deduce from the symbols and lines on the map the differences of elevation and then to visualize the scene in the mind's eye. This is not easy and can be acquired only by practice and actual comparison of a map with the area mapped, picking out on the map the features that can be seen, or looking for and discovering in the field the features shown on the map. In reading a map, just as in ordinary reading, the first thing to be done is to learn the symbols. On all maps there is a reference to the symbols and abbreviations used. This should be carefully studied and committed to memory, particularly since all map-making services do not have the same practice in this regard.

The sheets of the Sectional Map of Canada are based upon the Dominion lands system of survey whereby the agricultural land is subdivided into townships six miles square. Each sheet includes eight townships north and south, and fourteen or fifteen ranges east and west. The sheets, 24 inches by 34 inches, are printed, usually in eight colours, on either thin or thick paper. A concise statement of the features shown in accordance with the latest practice—for the earlier maps differ in some of these details—is as follows:—

Latitude and Longitude.—Latitude and longitude are shown for each 15 minutes and each intermediate minute is shown by alternate black and white spaces along the borders.

Townships.—The township outlines are shown by a neutral coloured band. The section lines, where there are no roads, are shown by dotted black lines, the quarter-section lines being also in the same colour. The townships and ranges are numbered in the margins in blue. Thus the system of survey in the Canadian West serves the same purpose in locating any point as does the system used on all European military maps, by which the map is divided off into squares with each square numbered or lettered. Thus on the sheets of the Sectional Map of Canada there is no difficulty in locating any section or quarter-section.

Initial Meridians.—These are the north and south lines from which the ranges number. With the exception of the Principal meridian they lie at regular intervals of 4 degrees of longitude. Thus, the Second meridian is at 102 degrees west, the Third meridian at 106 degrees west, etc. The Principal meridian was laid out as a starting point for the system of survey and in later years the longitude was determined as 97 degrees 27½ minutes (nearly) west of Greenwich. The meridians extend north from the International boundary, and section and township corners are established on them. The Fourth meridian running from the International boundary to lake Athabaska, the fifth meridian running from near the International boundary to township 112, and the Sixth meridian running from township 47 to Mackenzie river are, respectively, the three longest surveyed straight lines in the world.

Base Lines.—The north boundaries of townships whose numbers are multiples of four are base lines. The first base line is the International boundary, the Second lies north of township 4 and so on northerly. These were run westerly from the township corners established on the initial meridians, and townships of equal width were laid off on the base lines. There is an exception in the case of those base lines lying east of the Principal meridian which were run easterly instead of westerly.

Correction Lines.—These are midway between the base lines. It follows that the north boundaries of townships whose numbers are multiples of two, but not of four, are correction lines.

Jogs.—Jogs regularly occur in the north and south road allowances. These are a necessary result in trying to fit the six-mile-square townships of the survey system to the spherical surface of the earth. Each base line follows closely

along the circle that passes around the earth at that latitude. As each successive latitude circle becomes smaller as one goes north, so do the distances on the base lines between any two initial meridians of survey. Thus it follows that any number of townships laid off from an initial meridian along any one base line extends in actual longitude a little farther west than if laid off on a base line to the south.

Again, as road allowances are run from the base lines twelve miles each way to the correction lines in a due north and south direction as nearly as possible, the two townships north of any given base line tend to become narrower and the two south of the base line wider. Thus the roads running north from one base line and these running south from the next base line do not meet on the correction line, and the jogs result. The amount of the jog increases with the distance west from the initial meridian, (easterly from the Principal meridian). It is twice as great, for instance, at range 20 as at range 10.

Roads.—The roads are classified in four different classes depending upon their conditions and use:—

Class 1.—Roads which are the main highways between cities, or the tourists' roads, are shown by a double black line filled in with red.

Class 2.—Roads which are the main roads between towns, or the main roads serving large districts, are shown by a double black line filled in with brown.

Class 3.—Roads which are local roads well travelled and usually in good condition are shown by a solid black line.

Class 4.—Roads which are local roads, with little travel and usually in poor condition, are shown by a broken black line.

Pack trails.—Pack trails are shown by a dotted black line.

Great care is taken to have the roads on the map as they actually exist on the ground at the time the investigation survey is made. Road diversions are in their exact positions and wherever a road leaves a regular road allowance its course through the section is carefully mapped. It is apparent that with all the roads and trails so clearly shown, a motorist may readily pick the best route between any two towns, or from any town to any quarter-section, or from any quarter-section to any other quarter-section, even though these may be many miles apart. A motorist would simply lay out his route so as to follow roads shown in red as much as possible, then those in brown and then the solid black ones, only using the poorest ones, those shown in broken black, where absolutely necessary.

Bridges, Fords, and Ferries.—Wherever a road crosses a stream its mode of crossing is clearly indicated. The letter "F" is used if by a ferry, the word "Ford" if by a ford. No special symbol is used for a bridge as it is considered self evident, that if the crossing is neither a ferry nor a ford it must be a bridge.

Railways.—Railways, stations, sidings, and stops are shown on the map in the following ways:—

Single track railway.—A heavy solid black line.

Double track railway.—A heavy solid black line with short cross lines.

Electric railway.—Same as double track railway, but the lines much finer.

Stations.—Small solid black oblong alongside the line showing the railway.

Siding or stop.—Small black circle on the line showing the railway.

Water Areas.—All water areas are shown in blue thus:—

Permanent lake.—Solid blue with outline in blue line. The general depth of the water in feet is given for all permanent lakes, where possible.

Non-permanent lake.—Area filled in with broken horizontal blue lines, with outline in blue line.

Alkaline flat.—Area filled in with blue dots with outline shown by blue dots.

Marsh or muskeg.—Open marsh, bog, or muskeg is shown by conventional blue hachures as on all topographic maps, while wooded muskeg or swamp has in addition a green tint.

River three chains wide or over.—Double blue line with space between in solid blue.

River under three chains in width.—Single blue line.

Brook or creek.—Single blue line.

Non-perennial stream.—Broken blue line.

Irrigation canal.—Double straight blue line.

Drainage canal.—Single straight blue line.

Woods and Forests.—Wooded areas are shown by a green tint.

Buildings.—Buildings are small black squares. In the case of farm buildings, one symbol only is shown for each group of buildings, except where there are two or more dwelling houses on one quarter-section.

School.—Small black square with flag.

Church.—Small black square with cross.

Rural post office.—Small black square with the letter " P " alongside.

Cities, Towns, or Villages.—The built-up areas of the larger centres of population are shown in as much detail as the scale will permit. Where class 1 or class 2 roads pass through them the routes are indicated. Symbols are also used for elevators, garages, post offices, and telegraph offices, thus:—

Post office.—The letter " P ".

Telegraph office.—The letter " T ".

Garage.—The letter " G ".

Elevator or elevators.—The letter " E ".

Telephone Lines.—Telephone lines are indicated by small black dashes alongside the roads. These, for convenience, are always shown on the map on the south or west side of the roads.

Power Transmission Lines.—Power transmission lines are shown by small red dashes instead of black.

Mines or Quarries.—The location of a mine or quarry is shown by a conventional symbol resembling an axe and pick crossed.

Forest Reserves.—The boundaries of forest reserves are in a purple band of colour. Ranger stations and look-out towers have the symbols in black of a flag and pennant respectively.

Indian Reserves.—The boundaries of Indian reserves are in red hatching.

Dominion Parks.—The boundaries of Dominion parks are in an orange band of colour.

Bird Sanctuaries.—The boundaries of bird sanctuaries are in neutral hatching.

Public Shooting Grounds.—The boundaries of public shooting grounds are in blue hatching.

Information along Borders.—Along the borders of the map the degrees of latitude and longitude are indicated, and in the case of class 1 and class 2 roads the distances to the nearest town or city are given. For convenience in dealing with information extending from one sheet to another a strip approximately one-half mile in width is included, overlapping on areas shown on adjoining sheets.

Relief or "Lay" of the Ground.—The relief of the country, or "lay" of the ground, except in a few cases, is shown on these maps by means of 50-foot contour lines. These contour lines are in brown with every fourth one emphasized. A contour line is a line of even elevation, i.e., every point on any particular contour line is the same height above sea level. They might also be described as successive shore lines, if we were to assume that the sea level would change. That is, if the sea were raised 2,000 feet, the 2,000-foot contour line would be the new shore line of the sea, and all summits above the 2,000-foot contour line would be islands. If a person were to trace out on the ground the course of a contour line, he would neither go up nor down hill, but would always stay on the same level. These contour lines indicate the places where the country is hilly or where it is nearly level, or where there are coulées and valleys, etc. From these the drainage basin areas for all streams can be estimated. The elevation also of any point on the map can be estimated within small limits, as the elevation of the country between any two contour lines is greater than the lower one and less than the higher.

The elevations upon which the contour lines are based are obtained from accurate spirit level surveys along the railway rights-of-way and along surveyed lines of the Dominion lands surveys system, and are reliable for all engineering purposes. Elevations in black figures from these surveys are shown at the railway stations and sometimes at township and section corners. The elevations of the contours are shown in brown. The crossings of the contours on such surveyed lines are accurately located and for the remainder of their courses are derived from trigonometric and barometric elevations which, although not of as great accuracy, furnish contours sufficiently accurate for all purposes that the scale of the map will allow.

THEIR USES

From what has been said many of the uses of a topographic map will already have been inferred. Possibly one of the first uses that may occur to a person is that it is an excellent road map. For use as such within the area mapped nothing could be better as it shows the way to get from place to place over the best roads. The grades can be estimated fairly accurately from a study of the contour lines and if heavy loads are to be hauled this is a matter of considerable importance. Of course, for an extended trip across country it is necessary to have a number of maps and this may not be as handy as having one map prepared expressly for showing the roads. The added charm of a trip when a series of good topographic maps is available will, however, more than compensate for the disadvantage of having to use several maps. When driving along a through road in an automobile, one of the party at a time can render the trip much more interesting by following on the map the progress being made and pointing out features to be looked for. A school house or church, a creek or little lake, or even a cross-road looks much more interesting if everybody is on the lookout for it. The contours indicate hills that must be climbed and the valleys passed through. The information about garages, post offices, telegraph offices, and telephone connections is always useful on such a trip and in case of break-down or accident may save much valuable time. If one should require the services of a garage man, it is much more satisfactory to look up the map and find out the nearest house with a telephone than to walk to the nearest house which may easily be half a mile away and then find that the nearest

telephone is a mile in the opposite direction. Most autoists have experienced such annoyances at one time or another.

In the engineering sphere a first requisite in any report is a topographic map. Where one already exists reference is made to it but if none exists sufficient surveys must be made to prepare a map or sketch of the area directly affected. In the latter case it is not unusual for a survey to be repeated several times in the same area for different purposes, each survey obtaining only the specific information in which the engineer may be interested at the time. A comprehensive survey at first with the resulting map saves a great deal of later work. The location among other things of a railway right-of-way, a main highway, an irrigation ditch, or a municipal drain, may be laid down approximately in correct position from the map, leaving only the details to be worked out later. Many other engineering uses are being continually made of topographic maps but these are more particularly studied in an engineering course and will not be further elaborated upon here.

For younger students or school pupils, the great advantage of topographic maps is in the study of physiography and geography which not only brings a most useful knowledge of the country but is most excellent for training and developing the faculty of careful and accurate observation. With a topographic map which includes the area where the school is located, the teacher of geography has an interesting subject to talk about and the pupils will be eager to pick out on the map the school building, their own and the neighbours' homes, the elevators, churches, etc. From these features the study may be extended to all the information shown on the map. It is preferable in every way in studying a map to take the class outside and have them locate their position on it. It is first necessary to be able to set the map correctly with respect to direction. No difficulty will be experienced in this matter in western Canada as the road allowances give correct directions at any place. The map should be spread out with the top pointing north and it is then correctly set. In addition to being able to locate oneself on the map, a person should be able to locate all the topographical features within his range of sight, and to look for and recognize all topographical features indicated on the map. Here is where it is very necessary to have the class familiar with the abbreviations and conventional symbols used. A very good exercise in studying the meaning of contour lines is to have the pupils judge from the map what features can be seen from where they are standing and what features will be hidden by hills or ridges. Another good exercise for part of the school work is to draw a cross section of a map or the profile of a railway line or a highway. Suitable horizontal and vertical scales may be chosen to show the information. In the field the idea of the scale used may be taught by having the pupils estimate certain distances and then check these up on the map. After the pupils have studied the local map, they should be tested out on those of country with which they are not familiar so that the teacher may be better able to judge whether they have grasped the essential ideas of map reading.

If a topographic map is available, it should always be taken along on a trip or cross country walk; if one leaves the roads at all a compass is also useful. A comparison should be made of what is found on the ground with what is shown on the map. The lot boundaries, houses, and as many of the natural features as possible should be located. If there is room on the map any useful details that are not shown should be marked in for future reference. If one can climb to the top of a hill or tower overlooking a wide stretch of country, a comprehensive test of one's ability to read a map and to observe accurately may be made. After looking carefully over a stretch of country, the map should be consulted for the features which have been observed. Conversely the map may be examined for a different section to give one an idea of what it should look like and then the mental picture may be compared with the reality.

Proficiency in map reading as said before only comes by much practice in the field, but after one has gained this proficiency it is quite possible to obtain from the map a comprehensive idea of an area which one has never seen; there will be a great many minor features which are not shown but the country as a whole can be visualized. In time, a map will represent to anyone properly versed in reading it, not a mere piece of paper with marks on it but a sort of miniature landscape that can be folded up and carried in the pocket. If a map be supplemented by a series of photographs of typical areas, then one may indeed become quite familiar with the district without actually seeing it. This is one of the things aimed at in all topographical work.

One use of topographic maps possibly not so self-evident to the general public is for official executive and administrative purposes. Federal and provincial officers in all departments and officers of municipalities make constant reference to them and use them for plotting statistics and information of all kinds. Areas in crop, locations of contagious diseases of man and beast, routes for rural mail delivery, and engineering problems are studied from these maps. The results are far more accurate and dependable than could otherwise be obtained. Topographic maps are also used as base maps for showing land classifications, soil surveys, geological data, etc., gathered by other services.

Another great use of a topographic map is in studying the distribution of population, areas of agricultural land, cleared land, timber types, etc. This information is always useful to merchants, dealers, bank managers, professional men and, in fact, to all who derive their living from dealing in the commodities of commerce or supplying services to the public.

Copies of the sheets of the Sectional Map which are described hereunder may be obtained upon application to the Surveyor General, Department of the Interior, Ottawa, for the nominal sum of twenty-five cents each. A complete catalogue of all the maps published by the Survey may be obtained free upon request made to the same office. By an arrangement with the educational authorities of Manitoba, Saskatchewan and Alberta, copies of any sheets of the Sectional Map may be obtained from the Deputy Minister of Education for the province at the reduced rate of ten cents per copy for school purposes.

THE WINNIPEG SHEET

The outstanding feature on this sheet is the city of Winnipeg with the railway lines and highways radiating from it. A study of the map, however, will furnish a surprising amount of information of various kinds, which was gathered by a survey party consisting of a Dominion land surveyor and several assistants and helpers during the survey season of 1919.

The area comprises townships 9 to 16, ranges 1 to 4, west, and ranges 1 to 11, east, of the Principal meridian, besides a number of parishes laid out along the Assiniboine and Red rivers. Some of the earliest surveys in the western provinces are included in this area, surveys made in the days when settlement was commencing around Fort Garry, now grown into the magnificent city of Winnipeg, the "Queen City" of the prairies. In order to allot land to the earliest settlers, many of whom were of French-Canadian origin, the parishes were surveyed into deep but narrow lots fronting on the rivers as was the system in Quebec. In the early days when travelling and freighting were chiefly by water, there were undoubted advantages in this system. Moreover, it gave far more facilities for community life than the rectangular system, but for farms these long narrow lots could never be as satisfactory as the square quarter-sections. In a country where there were no surveys a commencement

had to be made somewhere, so the location of the Principal meridian upon which the system of Dominion land surveys was to be based was picked upon quite at random. Its longitude was ascertained later to be about 97 degrees 27½ minutes west of Greenwich. The land boundaries as defined by the surveyed lines with their section and quarter-section survey monuments form the skeleton framework on which all the detailed information is based.

Besides the two rivers already mentioned, Winnipeg river cuts into the area on the east and the presence of falls along its course and the routes of the Winnipeg City and the Electric Railway power transmission lines are indicated clearly. Southerly portions of lake Manitoba and lake Winnipeg appear on the northern boundary of the map and the delta of Red river is particularly interesting. Another interesting water feature is the rivière Sale which rises within sight of the Assiniboine, later approaches it within two miles, then diverges from it and finally empties into Red river about ten miles above the mouth of the Assiniboine.

Such a course is possible, due to the nearly level character of the plain west of Winnipeg. This may be seen from the brown contours or form lines which are wide apart even with a contour interval of twenty-five feet, meaning that the slope between any two adjacent lines rises or falls that amount. Elevations ascertained from accurate surveys are shown at railway stations and the contour lines give the elevations of the remainder of the area since the elevation of any point lies between those of the two adjoining contours, or in the case of a hill is greater than that of the last contour shown. All information with respect to elevations was collected and reduced to mean sea level datum and were necessary to locate the contour lines, further spirit level surveys were made, especially in the fairly level areas adjoining the rivers. In bush country and in some rolling areas, information for contour lines was obtained from barometric elevations. On this map the highest contours shown are for two hills, one in township 10, range 10, the other in township 16, ranges 9 and 10, each of which rises above the 1,000-foot contour. The lowest elevation is for lake Winnipeg, 715 feet. The fact that each even hundred-foot contour line is emphasized is an assistance in picking out and following the elevations. It is interesting to follow one of these lines, often right across the sheet; for example, the 800-foot line entering the sheet near the southwest corner leaves the north boundary near the centre of the map. Another 800-foot line enters the sheet near the centre on the south and leaves the north boundary near the northeast corner.

The area lying south of Assiniboine river and west of Red river is extremely level and the soil admirably suited to agriculture, particularly since drainage ditches have been opened up, generally along the roads. The land is practically open except for a narrow fringe of scrub along the rivers and scattered clumps elsewhere. North of Assinboine river and west of Red river there is a strip of level land back from the rivers beyond which the surface becomes more undulating. Gravel pits are shown on the map east of Woodroyd and west of Woodlands and a quarry is indicated on the Stony Mountain penitentiary grounds. East of Red river lies a strip of good agricultural land devoted to grain growing and dairying. Most of this area was originally covered with bush and scrub and there are still considerable clumps remaining. Limestone bedrock outcrops in places and there are quarries near Lyall and Garson. The area around the south ends of the two large lakes and lying between them is very well suited to grazing and dairying and is rapidly developing along these lines. Looking at the easterly quarter of the sheet, it is noticed that there are very few roads and hardly any building symbols, indicating very sparse settlement. Examining this area further, the reason for lack of settlement is soon seen. Large areas are covered by marsh and muskeg and require extensive drainage and reclamation projects before being suitable for agricultural settlement. Brokenhead river with its tributary, Hazel creek, and Whitemouth river flow through these wet lands and would appear to be the natural lines of drainage.

In such a comparatively flat country there are no great natural obstacles to railway or highway construction, and all roads lead to Winnipeg as to a hub. The main line of the Canadian Pacific railway, double tracked except between Winnipeg and Molson, as indicated by the cross hatched line, the main line of the Canadian National railways, and the main line of the Grand Trunk Pacific railway (now also a portion of the Canadian National Railways system) pass through Winnipeg, besides branch lines in all directions. The trunk highway from the west, the one south to Emerson, and the good roads north to Winnipeg Beach and Selkirk are indicated by double lines filled in with red. Secondary highways have the double line but not the red filling, while local roads divided into well or slightly travelled are shown by continuous or broken black lines. The power transmission lines and the city aqueduct are features seen on very few other western sheets. It will be a good exercise for the pupils to measure the number of miles of railways, and roads of different classes on this sheet.

The subject of roads and railways is connected with the transportation of goods and commodities and thus we come to the homes where the producing and consuming people live. Outside of the cities, where it is clearly impossible to present the information, all the buildings existing at the time of the survey are shown. Farm houses, post offices, churches, schools, gasoline stations, etc., are indicated by their respective symbols. The letter " E " enclosed in a circle indicates at least one elevator but there may be more than one. It is interesting to note the distribution of rural population as indicated by the symbols for houses and buildings. Close to the city there are several localities where houses are close together, indicating market gardening areas or suburban development.

Winnipeg is one of the outstanding cities of North America. With a population of just over 200 in 1870 it has grown to the third largest city in Canada. It has abundant and cheap electric power brought from the hydro-electric stations on Winnipeg river. The aqueduct shown on the sheet furnishes pure soft water brought by gravity from Shoal lake in Ontario. But the chief advantage which the city enjoys is its position with respect to transportation. It is the pivotal point for railroads east, west, north, and south. The trade of the prairie provinces passes through it. It is the greatest grain market in the world. Literally thousands of loaded trains of wheat and other grains pass through the city bound for the head of the Great Lakes and the Atlantic ports. Winnipeg is likewise the great distributing centre for the country west of it. With its future growth assured there are engineering problems to be faced in connection with future town planning and community services of all sorts that will require skill and experience for their successful solution. This map will be used in planning and estimating on many of these problems.

THE REGINA SHEET

There are several outstanding features which immediately draw one's attention upon looking at the Regina sheet. The two large cities, Regina and Moose Jaw, in the south; the Qu'Appelle river dividing the area from west to east; and Last Mountain lake dividing the northerly portion from north to south are the principal items of interest on the map. A careful study, however, will reveal a surprising amount of information about the country.

The area included comprises townships 17 to 24, ranges 16 to 30, west of the Second meridian, the numbers of the townships and ranges appearing in large figures through the centre of the sheet, north and south, and east and west, respectively. In addition to the above townships there is a slight margin all around the sheet which overlaps the adjoining sheets. It will be seen that the westerly range on this sheet decreases in width as the townships number northerly. Townships 17 and 18, range 29, are whole townships and in fact there are two narrow townships 17 and 18, range 30, but townships 19, 20, 21, and 22, range 29, are not quite five miles wide while townships 23 and 24 are not

quite four miles wide. This system allows the areas of all full townships to be kept equal by decreasing the number of ranges as the surveys are carried northerly. The surveyed lines all over this sheet have the section and quarter-section corners marked by survey posts and monuments and comprise the skeleton framework upon which all the other information is based.

The water areas on this map are interesting. Qu'Appelle river entering on the west and flowing through Buffalo Pound lake has a very meandering course in its valley through the eastern half of the sheet. It would be a good exercise for the pupils to measure the length of the valley and then try to measure the length of the river with its various back and forth courses. It is not a large river but it has a valley of considerable depth and width. On the west of the sheet the valley averages about 200 feet deep while on the east it is about 350 feet deep. Last Mountain lake is a long narrow body of water but quite deep as the depths in blue figures indicate. It affords good boating and bathing and Regina Beach, Lumsden Beach, and Saskatchewan Beach are favourite summer resorts. Moosejaw creek flowing through the city of Moose Jaw and Waskana creek through Regina from the south, and Arm river from the north all enter the Qu'Appelle. There are a few small lakes and a few other creeks within the area, some of the creeks being non-perennial, that is, they dry up during the summer season. There is very little swamp or marsh land. Marshes are shown on the western border in township 18, range 29, on the eastern border in township 20, range 15, and in township 20, range 21.

A glance at the reference will show that areas of woods, bush, or scrub are shown by green tree symbols. The western half of the sheet has none of these symbols except in the valley of the Qu'Appelle, but a considerable area east of Last Mountain lake and another south of Qu'Appelle river in the eastern half of the map are shown as containing numerous clumps of woods and brush. This consists principally of poplar which is easily cleared. The preponderating area of prairie land at once marks this district as a grain growing country which is borne out by the presence of numerous railway lines with elevator symbols at the stations.

Although a grain growing district and largely prairie, the land is not level but rather rolling with the valleys of the rivers cutting across the area and running back up the creeks. These valleys are indicated by the contour lines shown in brown with the elevations in feet also in brown. The difference in elevation between any two adjacent lines is 50 feet so that the steepness of the river valleys may be estimated. In addition to those along the valleys these lines are shown all over the sheet, the distance between them indicating the slopes. Where two contour lines are far apart as in the area northerly from Moose Jaw the country is nearly level. The elevations above sea level, as obtained by accurate surveys, are shown at railway stations and it is interesting to follow along the railway lines noting the elevations and seeing the contour lines which are crossed. This gives one a fair idea of the grades on the railway. Another useful exercise is to follow contour lines which cross a river or creek, noting how far up the valley they run before crossing the water to the other side and then down again. By this means one may estimate the fall of the river and from that information get some idea of how fast the water runs. The Qu'Appelle river, for instance, does not fall fifty feet in the easterly half of the map. That explains the numerous windings in its channel and its slow current. The highest elevation shown on this map is the hill at the southwest corner which rises above 2,450 feet but not to 2,500 feet. The lowest point on the sheet is the water level of Qu'Appelle lake on the easterly boundary which is less than 1,600 feet but slightly over 1,550 feet according to the contour lines. Last mountain in township 24, range 21, rises to 2,100 feet while a hill in township 24, range 16, is 2,200 feet above sea level. A good example of a nearly uniformly rising slope is seen in the easterly portion of the map south of Qu'Appelle river northeasterly from the Saskatoon-Regina branch of the Canadian Pacific rail-

way. The land rises gradually toward Piapot Indian reserve, each distance of a little over a mile showing a rise of fifty feet.

This question of elevations and slopes has had a very determining influence on the transportation facilities. The railways must have easy grades and in following the different lines this fact is very well emphasized. There are no insuperable difficulties in railway construction in this district but advantage has been taken of the local topography wherever possible to keep down the grades. The Canadian National Railways line from Regina to Saskatoon has for instance a very good grade north of Qu'Appelle river as may be seen from the elevations at the stations. It is interesting to note too the way the Qu'Appelle valley is crossed. The railway enters the valley of Boggy creek at Bredin and runs down this valley, crosses the river, and follows up the Qu'Appelle valley, gradually rising from Lumsden nearly to Disley before it emerges. The Canadian Pacific Railway line from Regina to Saskatoon adopts a similar means for crossing the valley. The main line of the Canadian Pacific railway, double tracked (note the crossed line), the main line of the Canadian National railways, and the main line of the Grand Trunk Pacific railway (now also a part of the Canadian National Railways system) cross this map sheet while several branch lines diverge from Regina and Moose Jaw.

In addition to railways the highways and roads are shown. Several trunk highways cross the area, these being main thoroughfares. The east and west highway from Calgary to Winnipeg, the Saskatoon-International boundary road through Moose Jaw, and the two roads from Regina to Saskatoon are indicated by a double line filled in with red. Secondary roads between local places are shown by a double line without the red filling. Two classes of local roads are shown, the one fairly well travelled, the other slightly so. The pupils should measure with a scale or rule the number of miles of railway line, trunk, and secondary highways, and the two classes of local roads on the sheet and should work out the best route for travelling from one place to another using various combinations of places for this exercise.

Reference to places brings us to another important class of information on the map. Buildings are shown, and by consulting the list of symbols these can be picked out on the map. It is not possible to indicate every building in a city or town nor is it considered necessary to show that Regina, for instance, has a post office, telegraph office, churches, schools, etc., because everyone would know that. Leaving out the two large cities, the pupils should count the number of post offices, schools, churches, etc. The letter "E" in a circle indicates the presence of at least one elevator but there may be more than one. A comparison of the number of farm buildings in different townships is also interesting. In some sections only one building is shown indicating a large grain farm, while in other sections, all the quarter-sections have buildings on them indicating closer settlement and smaller farms. Not many of the river valley quarter-sections have houses on them as they are not good farms for grain growing. In connection with a study of the buildings, the extension of the telephone system to the majority of farm houses should also be noted, the spur line symbols showing the telephone lines.

THE EDMONTON SHEET

The city of Edmonton, North Saskatchewan river, Beaverhills lake, and the trunk highways featured in red will first draw one's attention upon looking at the Edmonton sheet. The area included comprises townships 49 to 56, ranges 15 to 28, west of the Fourth meridian, the numbers of the townships and ranges appearing on the margin of the map, north and south, and east and west, respectively. In addition to the above townships there is a slight margin all around the sheet which overlaps the adjoining sheets. The longitude of the Fifth meridian on the westerly boundary is seen to be 114° 00′ while the

longitude of the easterly boundary is between 112° 02′ and 112° 03′. It will be seen that the townships on the west side of this sheet against the Fifth meridian are fractional, range 28 being about two miles wide at the south side of the sheet and running out at the correction line on the north boundary of township 54. North of this correction line, townships 55 and 56 of range 27 are also fractional, being about five and a half miles wide.

The North Saskatchewan river is the outstanding stream on this map. It holds a direct northeasterly course through the city of Edmonton. This large modern city has been built around the site of old Fort Edmonton, the trading post in the days when travel was entirely by water. The map shows other traces of early settlement in the settlement lots enclosed by a neutral hatched border, at Edmonton, Fort Saskatchewan, and St. Albert. It was customary in days gone by to lay out lots for settlement with frontage on navigable rivers or lakes, a system which is still used to a limited extent at the trading posts and outlying settlements in the north. At Edmonton all but a few of the old river lots are included in the city.

Returning to a study of the drainage of the area covered by this sheet, Sturgeon river flowing through the town of St. Albert, and Beaverhills creek draining Beaverhills lake are most noticeable. Both are tributaries of the North Saskatchewan river as well as Vermilion river along the east edge of the sheet. A number of creeks will be noted, some of which are shown in a broken blue line indicating that they are intermittent or dry at times. In addition to Beaverhills lake there are a number of other large lakes and it would be an interesting exercise for a class in geography to make a sketch on a reduced scale showing the larger lakes and more important streams.

It is interesting also to note that the depths of the lakes are shown in blue figures and it will be seen that Beaverhills lake, although the largest, is comparatively shallow with a maximum depth of 14 feet as compared with a depth of 41 feet shown for Miquelon lake. The black figures on the lakes indicate their elevation or altitude above sea level. The surface of Beaverhills lake, for instance, is 2,202 feet above mean sea level. Small areas of marsh are shown around Whitford lake near the northeast corner of the sheet, near the Hay lakes on the south edge of the sheet, and in a few other places but it will be noted that there is only a very small percentage of marsh land in the area covered by this sheet. Sportsmen will be interested in the respective areas shown as bird sanctuaries and public shooting grounds.

Let us now study the physiography or physical features as revealed by the contours, which are shown in brown with their elevations in feet above mean sea level also in brown. The difference in elevation between any two adjacent contour lines is fifty feet, so that the steepness of the river valleys and the general slopes of the country may be estimated. Where two contours are far apart, as in the area between Beaverhills and Whitford lakes, the country is nearly level. Each 200-foot contour has been drawn heavier than the others and it will be seen that the contour along the top edge of the valley on the south side of North Saskatchewan river near the west edge of the sheet betwen Willow and Cutbank creeks is the 2,300-foot contour while the lowest one is the 2,100-foot contour. The elevation of the river at this point must therefore be less than 2,100 feet and more than 2,050 feet, otherwise the 2,050 contour would also be shown. The depth of the valley is therefore over 200 feet. Similarly opposite the mouth of Sturgeon river, a short distance below Fort Saskatchewan, it will be seen that the top contour is 2,050 and the elevation of North Saskatchewan river is less than 2,000 feet. Looking more closely we see the 1,950-foot contour crossing the river just below the mouth of Sturgeon river, and notice that the valley at this point is 100 feet deep. We now also have an idea of the grade of the bed of North Saskatchewan river since it drops over 100 feet and less than 150 feet between the west edge of the sheet and this point below the mouth of Sturgeon

river. It would be a good exercise for a class in geography to find where the 2,000-foot and 2,050-foot contours cross the river and to measure the distance between contour crossings to determine the distance the river flows in order to drop 50 feet. This might be done with a piece of thread.

Examining Whitemud creek just west of Edmonton, the 2,050 contour crosses near its mouth and following the creek south we find a number of other contours crossing, the highest of which is the 2,350 contour crossing the creek near the lower edge of the sheet. It will be seen that not only does Whitemud creek drop far more rapidly than North Saskatchewan river, but that the grade increases as it approaches the river, as shown by the decreasing distance between contour crossings, and that the depth of its valley increases until it becomes a deep coulée or ravine in the last few miles. Look now at its branch, Blackmud creek. The 2,250 contour crosses the creek just south of Ellerslie showing a 200-foot drop in a few miles to the river. Following up the creek we find a series of widenings forming a chain of lakes, the upper one of which is at an elevation of 2,285 feet, thus showing a drop of only 35 feet in about 18 miles. Also instead of coming from comparatively flat country like Whitemud creek, the Blackmud emerges from a deep valley in hilly country. The 2,450 contour marks the summit east of Saunders lake whereas the elevation of the lake is 2,274 thus indicating a hill over 175 feet high.

It may be noticed that the hilly country extends east nearly to Beaverhills lake and north to Bruederheim. Further examination of the contours will show that there are many summit or closed contours marking tops of hills and many creeks draining north, east, and west. Considering also the general irregularity of contours, this area might be called broken, hilly country but it is not so broken nor so hilly as to be of little value as will be seen by looking at the square building marks indicating occupied quarter-sections.

What are the highest and lowest elevations on the sheet? Four 2,600-foot summit contours are to be found near Miquelon and Ministik lakes. These are the highest points. The lowest point is where the North Saskatchewan river leaves the north side of the sheet, below the 1,950-foot contour.

This study of the topography of the country naturally leads to consideration of its transportation facilities. Railways must have easy grades, and they should be located so that they will tap productive country and not be too close to a competing line. There are no insuperable difficulties in railway construction in this district but advantage has been taken of the local topography wherever possible to keep down the grades.

It will be noticed, for instance, that the line of the Canadian National railways from Vegreville to Edmonton strikes a direct route from Vegreville to Bruederheim, which town is situated at the foot of a uniform descent from the high country to the south. Having turned the toe of the hill this line then heads direct to Fort Saskatchewan where the valley hills of the North Saskatchewan have an easy slope and the crossing of the river is easily negotiated with a low level bridge. The elevations of the railway stations are shown by black figures. From these and the contour crossings we can easily study the grades of the railway. Starting from Vegreville at an elevation of 2,091 feet the railway climbs gradually away from the crossing of Vermilion river to a summit near Hilliard, with just one short dip where it drops below the 2,250 contour near Mundare. From Hilliard it descends to the crossing of Beaverhills creek and continues its descent to the North Saskatchewan by following along the valley of Beaverhills creek to Bruederheim, thence continuing a gradual descent to the bridge at Fort Saskatchewan. If one wished to climb a steep hill or mountain side with the minimum effort he would not climb straight up the face of the hill but would choose a diagonal route, gradually ascending. The contours show that the railway does this in climbing from the low level bridge at Fort Saskatchewan to the station at Edmonton which is at an elevation of 2,185 feet.

Looking at the Grand Trunk Pacific railway we see another interesting example of the effect of topography on railway location. At first glance it would appear that this line climbs right over the hills but on closer examination it will be seen that the engineers chose a gap between the higher hills. The railway climbs from Tofield up the valley of Hastings creek and after passing Hastings and Cooking lakes descends along a valley by way of Ardrossan and Bremner, crossing North Saskatchewan river in this case by a high level bridge at a point where the contours show the valley to be narrow. Edmonton is the commercial centre forming the hub from which the railways radiate, each line in the same way taking full advantage of the local topography to give it the best grades.

It will be noted also that the trunk highways radiate from Edmonton. In the revision of the location of portions of these roads or in the extension of the system the topographic map is of great service to the highway engineer in showing him the distribution of population and in helping him also to take advantage as far as practicable of the local topography in avoiding hills, etc. The trunk highways are shown by a double black line filled in with red. Secondary roads between the more important towns and localities are shown also by a double black line but without the red filling. Two classes of local roads are shown, the one well travelled, the other slightly so. The pupils should work out the best route for travelling from one place to another using various combinations of places for this exercise.

Reference to places brings us to another important class of information on the map. The agricultural development may be estimated quite closely by observing the existing wooded areas and the number of quarter-sections occupied. Buildings are shown and by consulting the list of symbols one may pick out the churches, schools, elevators, etc., as well as the location of each group of farm buildings. It is not possible to indicate every building in a town, the intention being rather to show the built-up areas; nor is it considered necessary to show that Edmonton has a post office, telegraph office, gasoline stations, churches, schools, etc., because every one would know that. A comparison of the number of farm buldings in different townships is also interesting. Likewise, comparisons of the mileage of roads opened for traffic in various townships will be of interest in comparing progress of development. Telephone lines are shown by spur marks along roads. It will be interesting to follow these lines on the map and plan extensions to serve each farm house with a minimum of mileage.

THE BANFF SHEET

This map contains features not seen on any of the others already described. The crest of the Rocky mountains crosses the southwesterly corner and the eastern slope of this great range is the predominating topographical feature of the map. Several mountain peaks tower over 10,000 feet above sea level while many others rise to 8,000 feet or more. Mount Ball, 10,865 feet, and Storm mountain, 10,372 feet, on the crest of the range, and mount Aylmer, 10,375 feet, mount Pulsatilla, 10,060 feet, Bonnet mountain, 10,615 feet, Ptarmigan peak, 10,070 feet, mount St. Bride, 10,875 feet, mount Douglas, 10,615 feet, and Cataract peak, 10,935 feet, in addition to a few unnamed peaks, all lying east of the crest, are over 10,000 feet in height. The crowded contour lines at 250-foot intervals indicate very forcibly the mountainous character of the western half of this area. On the eastern half the contour interval is 100 feet, the scale of the map allowing such to be shown where the land is not so rough.

The area includes townships 25 to 32, ranges 1 to 15, west of the Fifth meridian. The townships in the mountainous area have not been surveyed, the outlines being shown in theoretical position. In addition, the location of the

city of Calgary has been included, as well as that part of the route of the Calgary to Banff automobile highway which lies slightly outside the above townships, in order to make a more complete map.

The trunk highways are shown by a double line filled in with red. Two of these run out of Calgary, one northerly to Edmonton, the other westerly to Banff, there connecting with the Banff-Windermere highway. These highways also continue southerly and easterly from Calgary as indicated. Possibly the best way to study this map is to imagine ourselves taking a trip from Calgary westerly by automobile along the highway shown in red. This highway follows the Bow river valley and closely parallels the main line of the Canadian Pacific railway. Leaving Calgary with an elevation above sea level slightly over 3,400 feet, the road ascends diagonally out of the Bow valley and we come within sight of the Rocky mountains stretching north and south as far as the eye can see. The country in the easterly part of the sheet is heavily rolling as may be seen from the contour lines. On account of this and its high elevation this area is more adapted to ranching than to grain growing. After passing through the town of Cochrane, the road crosses several tributaries of Bow river, the largest of which is Ghost river. After crossing this stream the road traverses Morleyville settlement and then enters Stoney Indian reserve. The easterly part of our trip is through prairie but in the Indian reserve we run into park land with light woods indicated on the map by a light green colour with tree symbols in black, indicating deciduous trees, scattered sparingly over it. The coniferous tree symbol is the one looking like a pine tree and will be met with farther along the route where the darker green tint indicates heavy woods.

After crossing the western boundary of the Indian reserve we are in Rocky Mountains park and fairly into the mountains. On both sides of the valley the mountains rise to about 5,000 feet above the river. At about 85 miles from Calgary we reach Banff which is the centre for tourists in this part of the mountains. Here are the administrative headquarters for the park and many natural attractions have been made accessible by road or pony trail. Some of these attractions are indicated on the map—the animal paddock, Vermilion lakes, the government baths at the Cave and Basin and the Upper Hot Springs; Sundance cañon, etc. A good road leads to lake Minnewanka from the shores of which high mountains rise on either side. An idea of the steepness of these mountains may be obtained from the elevations shown. Lake Minnewanka is 4,769 feet above sea level, while within two miles from it mount Inglismaldie rises to 9,725 feet, being a rise of a little over one foot in every two feet of distance. This is, of course, the average as portions of the ascent are much steeper than others as may be seen from the contour lines. Mount Aylmer, just north of the lake, is the highest peak in this locality. Along the highway a short distance before Banff is reached may be seen the hoodoos in the valley of Cascade river. The locality is shown on the map. The hoodoos are columns of hard clay which have withstood the destructive action of the storms by being protected on top by flat stones which shed the rain. Where not so protected the clay has been worn down and washed away leaving these curious columns standing there like clay men balancing stones on their heads. From time to time one of the stones does topple off and then the column crumbles under the action of the elements.

Leaving Banff the road continues up the Bow river valley, the river itself gradually lessening in size and volume. Near the Canadian Pacific railway station of Castle Mountain, the road forks, one branch continuing on along the railway to the crossing of the Great Divide at Kicking Horse pass shown on the adjoining map to the west, while the other branch turns up the valley of Altrude creek directly towards the height of land. This highway is a portion of the recently completed and now famous Banff-Windermere automobile road which

is a part of the Grand Circuit Tour which links up the Western States with the Canadian Rockies. The road crosses the crest of the Rockies through Vermilion pass at an elevation of 5,416 feet, into Kootenay park lying in British Columbia. This road makes accessible some of the finest scenery of the Rockies, the portion within the area shown on this map, commencing as it does at Calgary, being a gradual unfolding of views of massive mountains and wooded valleys, alpine lakes and perpetual ice, streams and waterfalls, shade and shadow.

There are many objects of interest not visible from the through highway which can be reached by side roads and trails. Others can only be reached by pony trails or by laboriously continuing on foot, carrying necessary supplies on one's back. Most ascents of mountain peaks must be made in this way and the Alpine Club of Canada under whose auspices many of the pioneering ascents have been made has a club house at Banff.

The drainage system of this district is interesting to study. Bow river has many tributaries the branches running far up into the mountain valleys. The northern part of the area including rather more than half the sheet drains into Red Deer river. The tributaries of these two rivers, if followed up, are seen to almost meet and it will be an interesting exercise to draw in a line representing the height of land or watershed between these two drainage areas.

The parks and Rocky Mountains forest reserve have been set apart from sale or settlement for the general advantage of all the people of Canada. These lands are administered by the Federal Government. Several ranger stations are shown in the forest reserve where officials of the Dominion Forestry Service are stationed to see that law and order are observed and to combat forest fires.

There is such a mass of information presented on a map like this that only a brief outline can be given in a short description and it remains for the student to try to visualize for himself what the district has to show to the observer.

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